

# PROCESS IMPROVEMENT USING SIX SIGMA METHODOLOGY

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A dissertation submitted in partial fulfillment of the  
requirements for the award of the degree of  
Master of Engineering (Industrial Engineering)

Faculty of Mechanical Engineering  
Universiti Teknologi Malaysia

MAY 2009

*Specially dedicated to..*

*My love for his endless encouragement, support and care,*

*and Mum, Dad, and Sis*

*for their love and support.*

## **ACKNOWLEDGEMENT**

The thesis project I have undertaken would not have been possible without the assistance from the many individuals whom I wish to sincerely thank from the bottom of my heart. First and foremost, I would like to express my sincere gratitude to my thesis supervisor, Prof. Dr. Sha'ri for his supervision, guidance and encouragement throughout the project. I am also thankful to Agilent Technologies (M) for providing me the opportunity for carrying out this project and especially my ad-hoc team members from Agilent for their assistance and support. My heartfelt thanks also go to the suppliers who have assisted me in the technical experiments and advice throughout the project.

Last but not least, my deepest gratitude to my loved ones, my family members whose patience and encouragement played the greatest role in sustaining me through the challenge of completing this thesis.

## ABSTRACT

The purpose of this thesis is to solve the screw stuck issue of Sensor Module in Agilent Technologies, using Six Sigma methodology D-M-A-I-C. The current yield loss due to this defect had contributed to the increased production cost due to higher material scrap and rework time. Project objectives were set in *Define* phase to increase the yield of both functionality and reworkability of Sensor Module from current baseline yield to 99.4% (targeted four sigma). The baseline data was collected in the *Measure* phase and shows that baseline yield for functionality and reworkability was 74% and 62% respectively. *Analyze* phase results revealed the relationship of vital few causes to the screw stuck issue, which led to the defect's root cause as thread galling. Thread galling phenomena was associated with the fasteners material and torque speed (rpm), therefore the relationship between these factors and the functionality and reworkability yield was developed. In *Improve* phase, the solution was chosen to replace the fastener's material and reduce the torque speed considering factors such as effectiveness, cost and lead time. Optimization test or DOE was carried out to determine the best options on the fastener's material selection and the torque speed. Experiment reveals improved yield with SP series nut new type, wax coated stainless steel screw, and manual torque driver. Pilot run was conducted successfully with 100% yield on functionality. In final *Control* phase, all the changes and implementation were institutionalized with proper training, documentation, process monitoring, response plan and sustainability plan. The result from the project has provided an insight on actual successful deployment of Six Sigma methodology DMAIC with application of its various statistical tools and techniques, and as the systematic problem solving framework on solving actual industrial issues.

## ABSTRAK

Tujuan thesis ini adalah untuk menyelesaikan masalah skru tersekat pada unit Sensor Module di Agilent Technologies dengan menggunakan metodologi “Six Sigma” DMAIC. Kemerosotan hasil daripada masalah ini telah menyumbang kepada kenaikan kos pengeluaran akibat kenaikan bahan sekerap and masa pembaikan. Objektif projek telah disetkan di fasa *Define* untuk meningkatkan hasil kefungsian dan pembaikpulihan daripada hasil dasar kini ke 99.4% (matlamat empat sigma). Data dasar kefungsian dan pembaikpulihan yang dikumpul di fasa *Measure* telah menunjukkan hasil sebanyak 74% dan 62%. Keputusan fasa *Analyze* telah menunjukkan hubungan antara beberapa kemungkinan punca penting untuk masalah skru tersekat, dan seterusnya telah mendedahkan punca sebenar iaitu “ulir skru meleceet”. Masalah “Ulir skru meleceet” yang berkait rapat dengan bahan skru dan nut, dan kelajuan tork (rpm) seterusnya mewujudkan perhubungan faktor-faktor tersebut dengan kefungsian dan pembaikpulihan. Pada fasa *Improve*, penyelesaian telah diambil untuk menukar bahan skru dan nut, dan mengurangkan kelajuan tork. Ujian optimasi atau DOE telah dijalankan untuk menentukan penyelesaian terbaik untuk bahan skru dan kelajuan tork. Eksperimen yang telah dilaksanakan telah menunjukkan hasil kenaikan dalam penggunaan nut baru jenis SP, skru keluli tahan karat bersalut lilin dan alat pemutar skru tork tangan dengan percubaan pengendalian 100% untuk hasil kefungsian. Pada fasa akhir *Control*, kesemua perubahan and implementasi adalah diinstitutasikan dengan latihan yang sesuai, dokumentasi, proses pengawasan, pelan respons and pelan pengekalan. Hasil kajian projek ini telah memberikan satu pengertian yang mendalam untuk aplikasi metodologi *Six Sigma* DMAIC sebagai satu kaedah penyelesaian masalah yang sistematik untuk penyelesaian masalah industri.

## TABLE OF CONTENTS

CHAPTER	CONTENTS	PAGE
	<b>TITLE</b>	i
	<b>DECLARATION</b>	ii
	<b>DEDICATION</b>	iii
	<b>ACKNOWLEDGEMENT</b>	iv
	<b>ASBTRACT</b>	v
	<b>ABSTRAK</b>	vi
	<b>TABLE OF CONTENTS</b>	vii
	<b>LIST OF TABLES</b>	x
	<b>LIST OF FIGURES</b>	xii
	<b>LIST OF APPENDICES</b>	xv
<b>CHAPTER 1</b>	<b>INTRODUCTION</b>	1
	1.1 Background	1
	1.2 Statement of the Problem	3
	1.3 Objectives	4
	1.4 Scope and Key Assumptions	4
	1.5 Organization of the Report	4
<b>CHAPTER II</b>	<b>LITERATURE REVIEW</b>	6
	2.1 Introduction to Quality Control	6
	2.1.1 TQM and Six Sigma	7
	2.1.2 Lean Manufacturing and Six Sigma	8
	2.2 Six Sigma Quality Philosophy	10

2.3	Six Sigma Principles	13
2.4	Six Sigma Project Selection	14
2.5	Six Sigma Tools and Techniques	17
2.5.1	Statistical Process Control (SPC)	19
2.5.2	Measurement System Analysis (MSA)	19
2.5.3	Failure Mode and Effect Analysis (FMEA)	20
2.5.4	Design of Experiment (DOE)	20
2.5.5	Quality control and capability analysis	21
2.6	Success stories of Six Sigma	22
2.7	Obstacles of implementing Six Sigma	22

### **CHAPTER III METHODOLOGY**

3.1	Problem definition	24
3.2	Phase I: Define	24
3.2.1	Project Charter	25
3.2.2	SIPOC Analysis	30
3.2.3	VoC Analysis	30
3.3	Phase II: Measure	36
3.3.1	Operation definition of each CTQ	37
3.3.2	Baseline on each CTQ	38

### **CHAPTER IV RESULTS AND ANALYSIS**

4.1	Phase III: Analyze	44
4.1.1	Nut analysis	51
4.1.2	Tightening torque and loosening torque analysis	55
4.1.3	Screw analysis	58
4.2	Phase IV: Improve	61
4.2.1	Decision matrix	62
4.2.2	Design of Experiment	65
4.2.3	Pilot run	68
4.3	Phase V: Control	72
4.3.1	Training	73
4.3.2	Documentation	73

4.3.3	Process monitoring	74
4.3.4	Response plan	75
4.3.5	Institutionalization	76
<b>CHAPTER V CONCLUSION AND FUTURE RESEARCH</b>		78
5.1	Conclusion	78
5.2	Future research	80
<b>REFERENCES</b>		81
<b>APPENDICES</b>		84



## LIST OF TABLES

<b>TABLE NO.</b>	<b>TITLE</b>	<b>PAGE</b>
2.1	Six Sigma and defects per million opportunities	14
2.2	Process capability (Cpk) implications	21
3.1	Gantt chart for Sensor Module project	28
3.2	Labor and Material Cost Savings	28
3.3	Roles and responsibility of Sensor module project	29
3.4	Voice of the Customer Questionnaire	31
3.5	Analysis Table for Voice of the Customer Data	32
3.6	Kano Questionnaire for Sensor Module project	34
3.7	Tabulated Responses to Kano Questionnaire	34
3.8	Definition of CTQs	35
3.9	Baseline capability data for Sensor module	39
3.10	Summary of theoretical Reworkability of Sensor module	43
4.1	FMEA for Sensor Module	48
4.2	Failure symptom categorization and its ratio	51
4.3	Test results CLS-M3-2	53
4.4	CLS-M3-2 torque out specification on different host material	54
4.5	Comparison between CLS-M3-2 and SP-M3-1	55
4.6	Tightening and Breaking torque measurement results	58
4.7	Decision matrix's criteria and its weightage	62
4.8	Decision matrix for possible solution for screw stuck	64
4.9	2 <sup>2</sup> Full Factorial Design with 4 replicates	65
4.10	New specification setting on new process	67
4.11	Data from the Pilot study (after implementation)	68

4.12	Check sheet for product defect recording	74
4.13	FMEA table after implementation	77

## LIST OF FIGURES

<b>FIGURE NO.</b>	<b>TITLE</b>	<b>PAGE</b>
2.1	Voice of the customer	11
2.2	A High Level Deployment Process for Six Sigma	12
2.3	Distance between target and tolerance limits if the process output is normally distributed and performing at Six Sigma level	13
2.4	Six Sigma organization infrastructure	16
2.5	The DMAIC funnel	17
2.6	Diagrammatic representation of the change process via the six sigma methodology	18
3.1	Production Scrap Cost trend in MTA from 2006 to 2008	26
3.2	Scrap cost distribution by products in 2008	26
3.3	Pie Chart of scrap parts of Sensor module	26
3.4	Sensor module unit with (i) closed cover and screws (ii) screw stuck on the main deck (internal assembly) where cover has to be broken to open up the unit	27
3.5	SIPOC Analysis of Sensor's Module disassembly process	30
3.6	Pictorial View of Kano Quality Categories	33
3.7	Run chart of Functionality	40
3.8	C-Chart of Functionality	40
3.9	Run Chart of Reworkability	41
3.10	Individual and Moving Range chart for Reworkability	41
3.11	Normal Probability Plot for Reworkability	42
3.12	Descriptive Statistic of Reworkability	42
4.1	Flowchart for Sensor Module process	45

4.2	VA/NVA Flowchart for Sensor Module process	46
4.3	Ishikawa (Fish Bone) Diagram on Screw stuck	47
4.4	Pareto chart of Vital few causes	49
4.5	Two of the three failure symptoms of screw stuck, (a) Screw stuck and (b) screw stuck and broken	49
4.6	Bar graph on screw stuck symptoms distribution on R (right) and L (left) positions: X1 Screw stuck, X2 Screw stuck and broken, and X3 Screw stuck on detached nut (from main deck)	50
4.7	Self-clinching nut CLS-M3-2 used in Sensor module's main deck	52
4.8	Self clinching nuts installed on Sensor module's main deck	52
4.9	Torque out test setup	53
4.10	Types of nuts selection based on application	54
4.11	Definitions of torque	55
4.12	Calculation of tightening torque of Sensor module screw	56
4.13	Method of tightening torque test of Sensor module screw	57
4.14	Tightening and Breaking torque measurement graph	58
4.15	Sensor module cover's screw: TORX-T10 M3X0.5 25MM-LG	59
4.16	Cross section of the screw stuck	59
4.17	Tree Diagram of screw stuck possible solutions	61
4.18	Pareto chart of standardized Effects	66
4.19	Main Effect plot for torque rpm for functionality	66
4.20	Changes on main deck's nut	67
4.21	Changes on torque rpm (torque driver)	67
4.22	Run chart of Reworkability (after implementation)	70
4.23	I-MR chart of Reworkability (after implementation)	70
4.24	Dot plot of Reworkability before and after implementation	71
4.25	Probability Plot of Reworkability (before implementation)	71
4.26	Probability Plot of Reworkability (after implementation)	72
4.27	Tests for Equal Variances on Before and After Implementation reworkability data	72
4.28	A visual form of SPC	75

4.29	Flow chart of troubleshooting guideline for screw stuck	76
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**LIST OF APPENDICES**

<b>APPENDIX</b>	<b>TITLE</b>	<b>PAGE</b>
A	Six Sigma Project Charter	84
B	Tightening Test Report (Bossard)	85
C	Torque-Out Test Test Procedure (PennEngineering)	92
D	Thread galling on Stainless Steel Article	98

## **CHAPTER 1**

### **INTRODUCTION**

#### **1.1 Background**

Six Sigma was introduced into the manufacturing arena in the early 1980s, by Bill Smith, an engineer at Motorola. Harry Mikel then formulated the details of Six Sigma methodology that generated widespread enthusiasm toward the concept and its application (Eckes, 2005). The initial approach Motorola took toward implementing Six Sigma was virtually at the tactical level. Motorola eventually developed its Six Sigma tools curriculum and created Six Sigma practitioner qualifications. These early efforts led the company to winning the Malcolm Baldrige Award in 1988 (Hendericks and Kelbaugh, 1998).

Traditionally, Six Sigma is a statistical concept that measures a process in terms of defects and is used to represent the range of values of a population with a normal distribution as mathematically 99.73 percent of all values can be expected to fall within a range that extends from three sigma below and three sigma above the population mean (Goh et. al., 2004). Six Sigma enthusiasts seek exponentially higher quality results having as an ultimate goal of virtually all products, attributes, or

services being with specification ( $\mu \pm 6\sigma$ ) thus producing fewer than 3.4 defects per million even when shift of  $1.5\sigma$  occurs.

One of the first organizations to inquire about Six Sigma from Motorola was Unisys. It was at Unisys that the term Black Belt was coined, as both Mikel Harry and Cliff Ames, a Unisys plant manager were both martial art enthusiasts (Eckes, 2005). Other large companies that has also embarked on the Six Sigma bandwagon include Texas Instrument (TI), Asia Brown Boveri (ABB), AlliedSignal and General Electric (GE).

Six Sigma is also a management philosophy aimed at improving the effectiveness and efficiency of an organization. (Eckes, 2005). Financial benefits are substantial when an operating system performs at 6-sigma quality level instead of 3-sigma quality level where control limits equal the specification limits. At the operational level, the goal of implementing “Six Sigma” is to move product or service attributes within the zone of customer satisfaction and reduce process variation (Blakeslee 1999, Hahn *et al.* 1999, Harry and Schroeder 2000).

Agilent Technologies is no stranger to Six Sigma, for it has engrained the quality improvement plan into its culture to ensure the quality of business decisions and strength in execution. Agilent is the world’s premier measurement company. Agilent operates two primary businesses, electronic and bio-analytical measurement, where the latter is supported by Agilent Laboratories, its central research group. Agilent is committed to providing innovative measurement solutions that enable the customers and partners deliver the products and services that make a measurable difference in the lives of people everywhere. Agilent is also a leading supplier to the telecommunications industry.



Agilent spun off from Hewlett-Packard Company in 1999 as part of a corporate realignment that created two separate companies. Its roots date to 1939, when Bill Hewlett and Dave Packard started a company that helped shape Silicon Valley and the technology industry. The two founders are renowned for their visionary approach to management (known as the “HP Way”) and for their commitment to making products that contribute to advances in science and technology. Agilent continues to support the values that made Dave Packard and Bill Hewlett’s company a success: dedication to innovation; trust, respect and teamwork; and uncompromising integrity. Added to these are speed, focus and accountability to meet customer needs and create a culture of performance that draws on the full range of people’s skills and aspirations.

Agilent has established Six Sigma vision and financial benefits guidelines, and developed its 1<sup>st</sup> wave of Black Belt and Champions since its launch in 2006. Six Sigma has now been recognized as a key methodology for achieving results by the shareholders, customers and employees. Supplemental skills development has also been extended for new and existing Belts and Champions, while quarterly management reviews at business & corporate levels are becoming standard.

## 1.2 Statement of the Problem

Gelato Sensor Module, one of Microwave Test Accessories Agilent produces has been experiencing screw stuck issue resulting in high material scrap in the production floor for the last two years, since 2006. The Sensor module is build by manual assembly, consisting of electrical and mechanical components, connectors, cables, covers and fasteners. The materials scrapped are the bottom cover and main deck used in the module when the screw assembly is stuck and unable to be removed. In this particular problem of the Sensor module, it provides an opportunity to further investigate how the Six Sigma methodology (DMAIC) and tools can be

used successfully to reduce the material variability and defects that leads to scrap of the Sensor module's bottom cover and main deck.

### 1.3 Objectives

The research's ultimate objective is to increase the yield of the Sensor Module by solving its screw stuck issue by focusing on the reduction of its process and material variability. Research will be carried out using Six Sigma methodology and tools to study the relationship that exists between key variables that influences the parts and the assemblies. Recommended solution will be implemented to monitor its effectiveness.

### 1.4 Scope and Key Assumptions

The focus of the research is to improve the quality and reduce the material defect of Sensor module's parts through Six Sigma methodology (D-M-A-I-C) within the research period of approximately 8 months. The research is only limited to one product, Sensor Module and is focused on the screw stuck on the cover only. The study will also not include Design for Six Sigma (DFSS), since a natural starting point of a Six Sigma venture is the use of Six Sigma in the production.

## 1.5 Organization of the Report

The first chapter of the thesis presents all introduction to Six Sigma and the problem statement. This is followed by the second chapter which summarizes the literature reviews. The third chapter contains the methodology of the research, consisting of DMAIC's Define and Measure phase, while the fourth chapter presents the research's analysis and results consisting of the final three phases of Analyze, Improve and Control. Finally the last chapter summarizes the conclusion and recommendation for future work.

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